SOV/179-59-3-9/45

AUTHORS: Bolotin, V. V., Gavrilov, Yu. V., Makarov, B. P. and Shveyko, Yu. Yu. (Moscow)

TITLE: Non-linear Problems of Stability of Plane Panels at High Supersonic Velocities (Nelineynyye zadachi ustoychivosti ploskikh paneley pri bol'shikh sverkhzvukovykh skorostyakh)

PERIODICAL: Izvestiya Akademii nauk, SSSR, Otdeleniye tekhnicheskikh nauk, Mekhanika i mashinostroyeniye, 1959, Nr 3, pp 59-64 (USSR)

ABSTRACT: The paper is a continuation of previous work (Refs 1 and 6). The question of the stability of plates and shells, exposed to a current of compressed gas, has so far been discussed in terms of a linear representation (Refs 1-5). For sonic flow and for moderate supersonic numbers M this hypothesis is apparently completely justified. However, for larger supersonic velocities, aerodynamic non-linearity becomes very appreciable. As was shown by Bolotin (Ref 5), solutions different from the unperturbed ones appear in aeroelastic problems, allowing for aerodynamic non-linearity, at velocities below the critical value. Among these solutions are some which are

stable in relation to sufficiently small disturbances. These solutions can be realised if the elastic system which is subjected to the sub-critical velocity is sufficiently irregular. All real constructions have some irregularities (defects of manufacture, deformations arising from aerodynamic heating, vibrations under the influence of atmospheric turbulence and other non-stationary factors, etc.). Thus in some cases, the critical velocity determined by the linear aeroelastic theory is only a lower limit to the critical velocity for real constructions. In the present paper, the edges of the plate are assumed to be simply supported and elastically restrained against axial displacements; the pressure on the plate is given by:

$$p = p_{\infty} \left(1 + \frac{\varkappa - 1}{2} \frac{v}{a_{\infty}}\right)^{\frac{2\varkappa}{\varkappa - 1}} \qquad (1)$$

where p is the pressure of the unperturbed gas, v is the normal component of surface velocity of the plate, a_{∞} is the velocity of sound in the unperturbed gas and

APPROVED FOR RELEASE: 06/20/2000 CIA-RDP86-00513R001031510001-9"

$\varkappa$ is the polytropy index. The component of load normal to the plate is

$$q = -\rho_0 h \frac{\partial^2 w}{\partial t^2} - 2\rho_0 h \varepsilon \frac{\partial w}{\partial t} + \Delta p \qquad (6)$$

where w is the deflection, ρ_0 is the density and h the thickness of the plate, ε is the damping coefficient, and Δp is the excess pressure, which can be expressed in terms of the Mach number and polytropy index by means of Eq (1). The problem then reduces to the investigation of the non-linear equation for the deflection of the plate, which contains q, subject to the boundary conditions. One solution is expressed as a double sine series and is dealt with both by an approximate numerical method, and with the aid of an electronic calculating machine. The results of the calculations for particular cases are shown graphically (Figs 4, 5 and 6), and indicate the existence of flutter in the panel. Acknowledgments are expressed to N. I. Chelnokov

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Non-linear Problems of Stability of Plane Panels at High Supersonic Velocities

and Yu. R. Shneyder of the Mathematical Machine Laboratory MEI, for participating in the calculations. There are 6 figures and 9 references, 7 of which are Soviet and 2 English.

SUBMITTED: November 18, 1958

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33397

S/572/60/000/006/015/018
D224/D304

10 6300

AUTHORS: Bolotin, V. V., Doctor of Technical Sciences, Professor, Makarov, B. P., Mishenkov, G. V. and Schveyko, Yu. Yu., Engineers

TITLE: An asymptotic method of investigating the spectrum of natural frequencies of elastic plates

SOURCE: Raschety na prochnost'; teoreticheskiye i eksperimental'nyye issledovaniya prochnosti mashinostroitel'nykh konstruktsiy. Sbornik statey. No. 6, Moscow, 1960, 231-253

TEXT: The authors consider the natural vibrations of a rectangular plate (with the sides a, b) of constant thickness. The general solution of wave equation near the edge x = 0 is looked for in the form

$$W(x, y) = X(x)\sin\frac{\pi(y - y_0)}{\lambda_y} \tag{5}$$

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It is deduced that

$$X(x) = C_1 \sin \frac{\pi x}{\lambda_x} + C_2 \cos \frac{\pi x}{\lambda_x} + C_3 e^{-\frac{\pi x}{\lambda_x}\sqrt{1 + 2B_x^2}} \quad (8)$$

$B_x = \lambda_x/\lambda_y$. The first two terms correspond to the asymptotic representation for the internal zone; the third describes the dynamic edge effect. Estimation shows that the width of the zone of edge effect does not exceed 1/2 of the wavelength. For a plate with all edges rigidly fixed,

$$\operatorname{tg} \frac{\pi a}{2\lambda_x} = \frac{1}{\sqrt{1 + 2B_x^2}}, \quad \operatorname{tg} \frac{\pi b}{2\lambda_y} = \frac{1}{\sqrt{1 + 2B_y^2}} \quad (14)$$

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An asymptotic method ...

is obtained ($\beta_y = 1/\beta_x$), which is reduced to a single transcendental equation for β_x, and β_x is computed by successive approximation the initial value being the asymptotic one $\beta_x = an/bm$; the final quantity is the factor $\alpha = (a/\lambda_x)^2 + (a/\lambda_y)^2$. The authors give a table showing successive stages of computation of α for ten lowest frequencies of a square plate, and compare all values with Iguti's results obtained from a series solution satisfying all boundary conditions (six terms of the series taken). The largest difference between the results is 2.53% for m = n = 1. A table of values of α for 16 lowest frequencies of plates with a/b = 0.25 and a/b = 0.50 is also given. The equation for β_x of a plate elastically fixed along all edges is deduced. In this case both β_x and a/λ_x must be found by successive approximation; a graph of values of α as a function of $k = 2\pi D/ac$ (D being the cylindrical rigidity of the plate, c the rigidity factor for the edge) for 10 types of vibration is given. The case of an axially compressed plate is treated

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in the same way. Four cases are considered next, in which some sides are hinged and other sides rigidly fixed. Values of α computed for these cases for a square plate are tabulated and compared with those obtained by Ritz's method. The authors remark that some formulae for principal frequencies by Ritz's method, given in other publications, also in two reference manuals, contain errors. Equation for β_x of an orthotropic plate is also derived and a table of α for a square plate is given. There are 9 figures, 6 tables and 14 references: 11 Soviet-bloc and 3 non-Soviet-bloc. The reference to the English-language publication reads as follows: K. Friedrichs, Asymptotic phenomena in mathematical physics. Bull. Americ. Math. Soc. 61, no. 6, 1955.

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44039
S/124/62/000/012/006/009
D234/D308

AUTHOR: Makarov, B.P.

TITLE: Nonlinear flutter of a plate clamped along its edge

PERIODICAL: Referativnyy zhurnal, Mekhanika, no. 12, 1962, 27, abstract 12B139 (Tr. Konferentsii po teorii plastin i obolochek, 1960, Kazan', 1961, 220-225)

TEXT: The author investigates the stability of rectangular plane plates clamped along the edge, with one side in a gas stream of large supersonic velocity. The normal deflection is assumed to be comparable with the thickness but small with regard to the length of the sides. Aerodynamic forces are determined on the basis of an asymptotic formula valid for velocities considerably exceeding the velocity of sound. The initial system of equations of motion is reduced to two ordinary differential equations by Galerkin's method. Periodic solutions of these are found by the method of small parameter. The calculations show that for moderate values of $\mu = Mh/a$ (M being Mach's number, h the thickness, a the

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Nonlinear flutter ...

length of the plate) the amplitude is of the order of h and the excitation of flutter i soft.
[Abstracter's note: Complete translation]

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28164

S/145/61/000/001/001/006
D294/D303

10 6300

AUTHOR: Makarov, B.P., Aspirant

TITLE: Stability of choked plates in a stream of compressed gas

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Mashinostroyeniye, no. 1, 1961, 3-12

TEXT: In this article, the stability of rectangular flat panels fixed on different supports is analyzed. The relation between the critical speed of flutter and the given parameters (value of compressing forces, ratio of plate sides, coefficient of damping) is determined. In order to establish the surplus aerodynamic pressure, the author uses a linear approximation of asymptotic formulae which is applicable at supersonic speeds. He expresses the pressure P as a function of the following parameters: P - gas pressure on the plate surface; P_∞ - undisturbed gas pressure; v - normal component of stream speed on the plate surface; a_∞ - sound velocity for undisturbed gas; x - polytropic exponent. The problem of super-

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sonic flow around the plates which have their sides supported parallel with the stream is discussed as well as the problems of flow around the plates having their sides choked parallel with the stream, or such plates which are choked all along their contour. For solving this problem, the author uses the Galerkin method as cited by V.V. Bolotin (Ref. 7: O primenenii variatsionnogo metoda Galerkina k zadacham flattera uprugikh paneley (Application of the Variation Method of Galerkin for Problems of Elastic Panels Flutter), "Izvestiya vysshey shkoly. Mashinostroyeniye", 1959 no 1'). Analyzing rectangular plates freely supported along their entire contour, Galerkin uses the theory of determinants; he proves that in this case determinants converge. This is also applied to plates choked on all sides. Thus, the determinant established by Galerkin belongs to the class of normal (converging) determinants. Graphs are given showing the dependence of plate oscillation frequencies on the Mach number, dependence of this number on parameters of compression charge and on the value of the ratio between the plate sides. There are 7 figures and 9 references: 6 Soviet-bloc and

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Stability of choked plates ...

S/145/61/000/001/001/006
D294/D303

3 non-Soviet-bloc. The references to the English language publications read as follows: H Ashley, G Zartarian Pistons theory - a new aerodynamical tool for the aercelastician, J Aeronaut. Sci., v 23, 1956, no. 6; I. Hedgepeth, On the flutter of panels at high Mach numbers, J. Aeronaut. Sci., v 23, 1957, no. 6; Y.C. Fung, On two-dimensional panel flutter J Aeronaut. Sci v.25, 1958, no. 3

ASSOCIATION: Moskovskiy energeticheskiy institut (Moscow Energetics Institute)

SUBMITTED: July 19, 1960

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S/145/61/000/005/001/009
D221/D306

10 6300

AUTHOR: Makarov, B.P., Aspirant

TITLE: Amplitudes of steady-state flutter of clamped panels

PERIODICAL: Izvestiya vysshykh uchebnykh zavedeniy. Mashinostroyeniye, no. 6, 1961, 11 - 25

TEXT: The article considers the stability and vibrations of clamped plates in a supersonic gas flow by taking into account geometrical and aerodynamic non-linearity. A rectangular plate with sides a and b (Fig. 1) is subject to supersonic gas flow at speed U, directed along axis 0x. Its normal bending, w(xyt) is assumed to be comparable to its thickness, but is small in relation to a and b. It is also assumed that tangent inertia forces are negligible compared to normal forces of inertia and the hypothesis of straight normals is fulfilled. This leads to

$$D\nabla^2\nabla^2 w = \frac{\partial^2 \Phi}{\partial y^2}\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 \Phi}{\partial x^2}\frac{\partial^2 w}{\partial y^2} - 2\frac{\partial^2 \Phi}{\partial x \partial y}\frac{\partial^2 w}{\partial x \partial y} + q, \qquad (1)$$

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and

$$\frac{1}{Eh}\Delta^2\nabla^2\Phi = \left(\frac{\partial^2 w}{\partial x\,\partial y}\right)^2 - \frac{\partial^2 w}{\partial x^2}\,\frac{\partial^2 w}{\partial y^2}, \tag{2}$$

concerning the deformations of plate, where $\Phi(x, y, t)$ is a function which expresses efforts in the central section, as in

$$N_x = \frac{\partial^2 \Phi}{\partial y^2}, \quad N_y = \frac{\partial^2 \Phi}{\partial x^2}; \quad N_{xy} = -\frac{\partial^2 \Phi}{\partial x\,\partial y}, \tag{3}$$

In the latter I is the cylindrical rigidity, E the modulus of elasticity, and q the normal load. The turbulent pressure at ultrasonic speeds is then given by taking into account the speed of the normal component of flow at the surface of plate v, the speed of sound for non-turbulent gas a_∞, and the index of polytropy . By introducing the Mach number $M = U/a_\infty$, the author writes

$$p = p_\infty + \varkappa p_\infty M\frac{\partial w}{\partial x} + \varkappa\frac{\varkappa + 1}{4}p_\infty M^2\left(\frac{\partial w}{\partial x}\right)^2 + \tag{6}$$

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Amplitudes of steady-state ...

$$+\varkappa \frac{\varkappa+1}{12} p_\infty M^3 \left(\frac{dw}{dx} \right)^3 + \dots \qquad (6)$$

for pressure on the surface subjected to gas flow p. The limit conditions are defined in relation to the type of plate fixing along its edges. The former can be determined with accuracy as far as sag w, is concerned, but it is difficult for T. Periodic solution of the system is found by the method of small parameters. For this purpose author considers a certain critical value of the reduced Mach number μ_*, by designating $\mu = \mu_* + \eta\mu_1$, where μ is the reduced Mach number, η is a small parameter, and μ_1 is of the same order as μ. By introducing the small multiplier, η, the author deduces

$$\ddot{\zeta}_1 + g\dot{\zeta}_1 + \zeta_1 - \mu_* K d_{12} \zeta_2 = \eta\mu_1 K d_{12} \zeta_2 - \eta \Psi_1 (\zeta_1, \zeta_2, \mu_* + \eta\mu_1), \qquad (15)$$

$$\ddot{\zeta}_2 + g\dot{\zeta}_2 + \omega_1^2 \zeta_2 + \mu_* K d_{21} \zeta_1 = -\eta\mu_1 K d_{21} \zeta_1 - \eta \Psi_2 (\zeta_1, \zeta_2, \mu_* + \eta\mu_1).$$

X

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the righ hand of which is considered as the resulting member. The critical reduced Much number μ_* is calculated from

$$\mu_* = \frac{\omega_2^2 - 1}{2K\sqrt{d_{12}d_{21}}} + (Og^2); \quad \omega_* = \sqrt{\frac{\omega_2^2 + 1}{2}} + 0(g^2). \tag{16}$$

Damping in systems that do not have multiple or adjacent frequencies is small; therefore, members containing g above the first power can be neglected. This leads to a set of equations

$$\left| \begin{aligned} &\omega_*^2 \frac{d^2\varphi_{11}}{d\tau_1^2} + g\omega_* \frac{d\varphi_{11}}{d\tau_1} + \varphi_{11} - \mu_* K d_{12}\varphi_{21} = 0, \\ &\omega_*^2 \frac{d^2\varphi_{21}}{d\tau_1^2} + g\omega_* \frac{d\varphi_{21}}{d\tau_1} + \omega_2^2\varphi_{21} + \mu_* K d_{21}\varphi_{11} = 0; \end{aligned} \right. \tag{?}$$

$$\left| \; \omega_*^2 \frac{d^2\zeta_1^{(1)}}{d\tau_1^2} + g\omega_* \frac{d\zeta_1^{(1)}}{d\tau_1} + \zeta_1^{(1)} - \mu_* K d_{12}\zeta_2^{(1)} = \right. \tag{21}$$

$$
\begin{cases}
= \Psi_1^{(1)}(A_1, \varphi_{11}, \varphi_{21}, p_1, \mu_1 \mu_*, \tau_1), \\
\omega_*^2 \dfrac{d^2 \zeta_2^{(1)}}{d \tau_1^{(2)}} + g \omega_* \dfrac{d \zeta_2^{(1)}}{d \tau_1} + \omega_2^2 \zeta_2^{(1)} + \mu_* K d_{21} \zeta_1^{(1)} = \\
= \Psi_2^{(1)}(A, \varphi_{11}, \varphi_{21}, p_1, \mu_1 \mu_*, \tau_1).
\end{cases} \tag{21}
$$

. . . .

$$
\begin{cases}
\omega_*^2 \dfrac{d^2 \zeta_1^{(s)}}{d \tau_1^2} + g \omega_* \dfrac{d \zeta_1^{(s)}}{d \tau_1} + \zeta_1^{(s)} - \mu_* K d_{12} \zeta_2^{(s)} = \\
= \Psi_1^{(s)}(A, \varphi_{11}, \varphi_{21}, \zeta_1^{(1)}, \ldots, \zeta_2^{(s-1)}, p_1, \ldots p_s, \mu_1, \mu_*, \tau_1), \\
\omega_*^2 \dfrac{d^2 \zeta_2^{(s)}}{d \tau_1^2} + g \omega_* \dfrac{d \zeta_2^{(s)}}{d \tau_1} + \omega_2^2 \zeta_2^{(s)} + \mu_* K d_{21} \zeta_1^{(s)} = \\
= \Psi_2^{(s)}(A_1, \varphi_{11}, \varphi_{21}, \zeta_1^{(1)}, \ldots, \zeta_2^{(s-1)}, p_1, \ldots p_s, \mu_1, \mu_*, \tau_1).
\end{cases} \tag{22}
$$

After some mathematical elaboration and by considering $\mu_1 = \mu - \mu_*$

$$A = \sqrt{\frac{8 K d_{21} (\mu - \mu_*)}{3 (L d c_0 - K \mu_*^3 b_0)}}, \tag{27}$$

is deduced for the first approximation amplitude. From the first condition of periodicity, and when $g^2 \ll 1$, a correction for amplitude A is obtained from

$$A_1 = A \left[\frac{a_1 d \mu_*^2}{108 d_{12} d_{21} L_0} + (\mu - \mu_*) \left(\frac{3 K \mu_*^2 b_0}{2 L_0} - \frac{L_1}{2304 K d_{12} d_{21} L^2} \right) \right]. \tag{30}$$

In the latter, the first member in the brackets expresses the effect of quadratic aerodynamic members and does not depend upon the speed of flow. The second member corresponds to the cubic members and provides the correction that increases with the rise of the reduced Mach number μ. Computations made for a square pannel demonstrate that the correction of amplitude of first approximation A_1 reaches significant values at speeds that exceed the critical speed. At the same time the results of first and second approximation differ little from each other in the vicinity of critical speed. As can be seen from Fig. 2, a three fold increase of the reduced Mach number μ, with respect to the critical value, results in a 10 % correction of the second approximation. A more precise calculation requires an increase in the number of members in the series. A plate with two sides that are parallel to the flow and clamped, the other two being supported, is then considered with the help of

$$w = \left(1 - \cos\frac{2\pi y}{b}\right)\left[f_1(t)\sin\frac{\pi x}{a} + f_2(t)\sin\frac{2\pi x}{a} + f_3(t)\sin\frac{3\pi x}{a} + f_4(t)\sin\frac{4\pi x}{a}\right] \quad (32)$$

A system of linear normal differential equations is evolved with dimensionless partial frequencies. To obtain the critical reduced Much number μ_*, it is necessary to determine the value of μ when two imaginary roots and the remainder of negative roots for

$$\lambda^8 + 4g\lambda^7 + a_6\lambda^6 + 3ga_6\lambda^5 + a_4\lambda^4 + 2ga_4\lambda^3 + a_2\lambda^2 + ga_2\lambda + a_0 = 0 \quad (34)$$

are found, where equal partial coefficients of damping are equal, then in the first approximation, μ_* is obtained without consideration of damping, i.e. instead of the polynomial in Eq. (34)

$$\lambda^8 + a_6\lambda^6 + a_4\lambda^4 + a_2\lambda^2 + a_0 = 0 \quad (36)$$

should be investigated. For systems with small damping, ω_* can be interpreted as a dimensionless frequency of flutter. It should be noted that with the increase in numerical order of members in the series of Eq. (32), the amplitude foreseen by the linear theory is decreased. The non-linear system of equations can be, therefore, linearized with respect to two last amplitudes, and after mathematical elaboration equations are deduced for amplitude A. There are 3 figures and 7 Soviet-bloc references.

ASSOCIATION: Moskovskiy energeticheskiy institut (Moscow Power Institute)

SUBMITTED: January 3, 1961

S/879/62/000/000/063/088
D234/D308

AUTHOR: Makarov, B. P. (Moscow)

TITLE: Application of the statistical method to the analysis of nonlinear problems of stability of shells

SOURCE: Teoriya plastin i obolochek: trudy II Vsesoyuznoy konferentsii, L'vov, 15-21 sentyabrya 1961 g. Kiev, Izd-vo AN USSR, 1962, 363-367

TEXT: The author applies the results of V. V. Bolotin (Izv. AN SSSR, OTN, no. 3, 1958), A. S. Vol'mir (DAN SSSR, v. 113, no. 2, 1957), L. H. Donnel and C. C. Wan (Journ. Appl. Mech., v. 17, no.1, 1950) to three examples (closed cylindrical shell subject to pressure in all directions, or to axial compression; cylindrical panel with imperfectly clamped edges, compressed along straight edges). In the second example experimental results published by other authors are quoted. There are 6 figures.

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S/179/62/000/001/022/027
E115/E135

/C 6/OC

AUTHOR: Makarov, B.P. (Moscow)

TITLE: Application of statistical method for analysis of experimental data on stability of thin cylinders

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye tekhnicheskikh nauk. Mekhanika i mashinostroyeniye, no.1, 1962, 157-158

TEXT: Using experimental data presented in the paper by L.A. Harris, H.S. Suer, W.T. Skene and R.I. Benjamin (Ref.3: J.Aeronaut.Sci., v.24, no.8, 1957) on the critical stresses (q_*) of thin-walled unstiffened circular cylinders under axial compression, and applying some of the theoretical results on the connection between q_* and a parameter u, which characterizes the initial imperfections of thin cylinders (to be defined in the sequel) stated in the paper by L.H. Donnel and C.C. Wan (Ref.4: J.Appl.Mech., v.17, no.1, 1950), the author attempts to find the distribution law of the parameter u from an experimental distribution of q_*. First, using the data of Harris and associates (Ref.3), experimental histograms of the distribution

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of q_*/q^o_* (q^o_* the upper critical stress for an ideal thin cylinder) for different intervals (0-500, 500-1000, 1000-2000 and 2000-4000) of values of the ratio $r = R/h$ (R - radius, and h - thickness of a thin cylinder) are calculated. Then, using the results of Donnel and Wan (Ref.4), a theoretical curve of the ratio q_*/q^o_* as a function of the parameter u is constructed. This parameter is defined by:

$$u = \zeta_o \frac{h}{R} n^2 m^{\frac{3}{2}} \qquad (3)$$

where ζ_o is the amplitude of initial deflection; n the number of waves in circumferential direction; $m = \ell_s/\ell_x$ the ratio of the length of a circumferential half wave to the length of a longitudinal one. Finally, knowing the experimental distribution of the critical stress and the theoretical relations between the stress and the parameter u, an experimental distribution of u is determined using the usual probability methods. The results of these calculations are presented in Fig.4 in the form of a histogram, on which, for comparison, the

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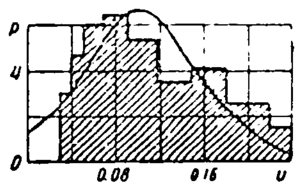
normal distribution curve with the mean, m = 0.1, and the standard deviation, σ = 0.06, is plotted. The author stresses that the experimental data available to him are insufficient for drawing any firm conclusions, and that his paper "should be considered only as a first attempt to estimate the character of the distribution of critical stresses and parameters of initial imperfections on the basis of experimental data".
There are 4 figures.
SUBMITTED: October 7, 1961

Fig.4



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S/258/63/003/001/011/022
E201/E141

AUTHOR: Makarov, B.P. (Moscow)

TITLE: Analysis of nonlinear stability problems of shells by a statistical method

PERIODICAL: Inzhenernyy zhurnal, v.3, no.1, 1963, 100-106

TEXT: This paper is concerned with application of the statistical method developed by V.V. Bolotin (Gosstroyizdat, 1961) to the determination of the stability of imperfect shells. The author considers the influence of imperfections on the upper and lower critical loads in cylindrical shells subjected to axial and hydrostatic loadings and in closed circular cylindrical shells under axial compression, unidirectional pressure and torsion. In the case of a shallow cylindrical panel the author investigates the influence of imperfections of the elastic supports on the behavior of the panel. The problem is to find the distribution of critical forces when the distribution of random imperfections is known. The basic equation is:

$$q_* = q_* (f_1, f_2, \ldots, f_n) \tag{1}$$

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where: q_* - upper critical force; $f_1, f_2, \ldots, f_n$ - continuous parameters of initial imperfections. The density of scatter is given by:

$$p(q_*) = \int_{-\infty}^{\infty} \ldots \int_{-\infty}^{\infty} p(\varphi, f_2, \ldots, f_n) \left| \frac{\partial\varphi(q_*, f_2, \ldots, f_n)}{\partial q_*} \right| df_2 \ldots df_n \tag{3}$$

For a particular imperfection the corresponding equations are:

$$f_1 = \varphi(q_*, f_2, \ldots, f_n) \tag{2}$$

and

$$p(q_*) = p(\varphi) \left| \frac{\partial\varphi(q_*)}{\partial q_*} \right| \tag{4}$$

where $p(\varphi, f_2, \ldots, f_n)$ - common density of probability.

The equation for the initial deflection is:

$$w_o = f_o \left(\sin\frac{\pi x}{a} \sin\frac{ny}{R} + \psi \sin\frac{2\pi x}{L} + \xi\right) \tag{5}$$

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where: L - length; n - number of circumferential waves; f_1, f_0 - amplitudes of deflection and initial deflection respectively; R - radius; ψ and ξ - parameters of the total energy of the system. It can be seen from the graphs that, depending on the size of the shell and the nature of the imperfections, the maximum density of probability of the critical force may approach the values of the upper and the lower critical forces calculated for perfect shapes.
There are 9 figures.

SUBMITTED: March 15, 1962

Card 3/3

BOLOTIN, V.V., doktor tekhn.nauk, prof.; MAKAROV, B.P., kand.tekhn.nauk; KURANOV, B.A., inzh.

Strength and rigidity of internal transformer windings. Elektrichestvo no.4:54-58 Ap '64. (MIRA 17:...)

1. Moskovskiy energeticheskiy institut.

KURANOV, B.A., aspirant; MAKAROV, B.I., kand. tekhn. nauk

Stability of multilayer elastic rings under the action of a uniform pressure. Izv. vys. ucheb. zav.; mashinostr. no.8: 49-57 '64. (MIRA 17:11)

1. Moskovskiy energeticheskiy institut.

BOLOTIN, V.V. (Moskva); KURANOV, B.A. (Moskva); MAKAROV, B.P. (Moskva)

Oscillations of circular transformer windings. Izv.AN SSSR.Energ.i transp. no.4:86-90 Jl-Ag '65. (MIRA 18:10)

BOLOTIN, V.V., doktor tekhn. nauk, prof.; MAKAROV, B.P., kand. tekhn. nauk; MISHENKOV, G.V., kand. tekhn. nauk; NAGORNOV, L.N., inzh.; POMAZI, L., aspirant

Some problems of dynamic stability of elastic rings subjected to sudden loading. Izv. vys. ucheb. zav.; mashin. str. no.6: 76-82 '65. (MIRA 18:8)

1. Moskovskiy energeticheskiy institut.

MAKAROV, B.P., kand.tekhn.nauk; CHICHENEV, N.A., inzh.

Snapping of thin elastic panels under the action of random pulsed loads. Rasch.na prochn. no.11:378-384 '65. (MIRA 19:1)

ACC NR: AR7004675 SOURCE CODE: UR/0124/66/000/010/V021/V021

AUTHOR: Makarov, B. P.

TITLE: On the snapping of an elastic shell subjected to random forces

SOURCE: Ref. zh. Mekhanika, Abs. 10V159

REF SOURCE: Dokl. Nauchno-tekhn. konferentsii po itogam nauchno-issled. rabot za 1964-1965 gg. Mosk. energ. in-t. Sekts. energomashinostroit. M., 1965, 275-286

TOPIC TAGS: elasticity theory, elastic shell

ABSTRACT: The snapping of a shell under the action of a stationary random load of the white-noise type is investigated. The application of the Bubnov-Galerkin method to the Foppl-Karman type of equation reduces the problem to a system of ordinary differential equations whose right-hand side is a random function of the white-noise type. (An approximation of the deflection, taking into account only two terms, is studied). It is shown that in this case, the evolution of generalized coordinates and speeds represents a continuous multidimensional Markov process.

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ACC NR: AR7004675

The joint probability density of coordinates and speeds satisfies the Fokker-Planck-Kolmogorov equation. The problem of determining the mean time for reaching a boundary in the phase space corresponding to shell snapping is reduced to a boundary value problem for the Pontryagin equation. The region which is "safe", from the standpoint of shell snapping, is determined in the phase space. An approximate expression for the trajectory of a phase point is found by the method of harmonic balance. Yu. N. Novichkov. [Translation of abstract] [DW]

SUB CODE: 20/

Card 2/2

MA[illegible]AR[illegible], [illegible]. (Mo[illegible]kva)

Behav[illegible]or [illegible] [illegible]om[illegible]essed and bent r[illegible] in the e[illegible] [illegible] [illegible]

Stroi.mek[illegible]. i [illegible] [illegible] r. 7 [illegible] - [illegible]'65.

(MIRA 18:10)

Makarov, B.V.
VARSHAVSKII, G.A., and B.V. MAKAROV.

K voprosu ob opredelenii optimal'nykh uslovil raboty vozdushno-reaktivnogo dvigatelia nepreryvnogo deistviia. (Tekhnika vozdushnogo flota, 1940, no.6, p.40-49, diagrs., bibliography)

Title tr.: Determination of optimum conditions of uninterrupted jet engine performance.

SO: AERONAUTICAL SCIENCES AND AVIATION IN THE SOVIET UNION, LIBRARY OF CONGRESS, 1955

MAKAROV, B.V.

BONDARYUK, Mikhail Makarovich; IL'YASHENKO, Sergey Mikhaylovich; SHCHETINKOV, Ye.S., doktor tekhn.nauk prof., retsenzent; MAKAROV, B.V., inzh., red.; PETROVA, I.A., izdatel'skiy red.; ROZHIN, V.P., tekhn.red.

[Ram-jet engines] Priamotochnye vozdushno-reaktivnye dvigateli. Moskva, Gos. izd-vo obor. promyshl. 1958. 391 p. (MIRA 11:4)
(Jet planes--Engines)

MAKAROV, B.V., inzh.

Precast reinforcements for stabilizing slopes of earth structures.
Gidr. stroi. 30 no.11:25-27 N '60. (MIRA 13:10)
(Precast concrete) (Soil stabilization)

GRABOVSKIY, L.K., inzh.; BASHILOV, G.N., inzh.; SOKOLOVSKIY, O.P., inzh.; KRASNOSEL'SKIKH, S.N., inzh.; ANTONOV, P.A.; BYKOV, V.A., inzh.; DANILOV. G.G., inzh.; GEL'FENBEYN, Ye.Yu., inzh.; PILIP, M.M., inzh.; MAKAROV, B.V., inzh.; RAGINSKIY, D.M., inzh.

Equipment of a working line of hot rolling mills. Sbor. st. NIITIAZHMASHa Uralmashzavoda no.6:70-96 '65.

(MIRA 18:11)

STATNIKOV, S. (Rustavi, Gruzinskaya SSR); MAKAROV, D. (Volzhskiy, Volgogradskaya oblast')

New cities. Zdorov'e 8 no.12:7-8 D '62. (MIRA 16:1)
(RUSTAVI--PUBLIC HEALTH)
(VOLZHSKIY (VOLGOGRAD PROVINCE)--PUBLIC HEALTH)

MAKAROV, D. A. PA-2T73

USSR/Soil Studies Mar 1947

"Temperature Optima of Soil Hydration," D A Makarov, 5 pp

"Pochvovedenie" No 3

The author concludes that low temperatures increase the degree of soil hydration in suspensions after thawing, and that this increase varies at different temperatures. The temperature optima lies between: -20°C to -76°C7 with maximum soil hydration at -50°C.

2T73

Chem A MAKAROV, D.A. 15

Effect of low temperatures on the hydration of soils D. A. Makarov (Chuvash Agr. Inst., Cheboksary). *Kolloid. Zhur.* 13, 298-300(1951). It has been shown (*Pochvovedenie* 1, 178(1947)) that soils first frozen at temp. T and then heated lost most H_2O during heating if T was $-20°$. After freezing and thawing pH of soils increased, and the max. increase took place after $T = -50°$. Now the effect of T on the elec. cond. κ of soil suspensions was detd. A chernozem had κ of 8.0–8.9 $\times 10^{-4}$ ohm^{-1} cm.$^{-1}$ before freezing, 11.1–11.2 after $T = 0°$, 12.5–12.8 after $T = -50°$, and 10.8–11.9 after $T = -100°$. A similar max. of κ after $T = -50°$ was observed also for a forest-prairie soil and a podzol soil. Chernozem and podzol suspensions were more rapidly coagulated after freezing and thawing than before, $FeCl_3$, $CaCl_2$, HCl, and KCl were used as coagulants. The amt. of "bound" water was max. after freezing at $-20°$. J. J. Bikerman

1957

SHVEDOV, V.P.; MAKAROV, D.F.

Separation of Li and K, Li and Cs. Zhur. prikl. khim. 38 no.4: 756-760 Ap '65. (MIRA 18:6)

L 46848-66 EWT(m)/EWP(t)/ETI IJP(c) JD/JG/GD

ACC NR: AT6024974 (N) SOURCE CODE: UR/0000/65/000/000/0198/0204

AUTHOR: Shvedov, V. P.; Makarov, D. F.

ORG: none

TITLE: Study of the separation of K from Rb, K from Na, K from Cs, Rb from Na, Rb from Cs, and Na from Cs

SOURCE: AN SSSR. Otdeleniye obshchey i tekhnicheskoy khimii. Zashchitnyye metallicheskiye i oksidnyye pokrytiya, korroziya metallov i issledovaniya v oblasti elektrokhimii (Protective metallic and oxide coatings, corrosion of metals, and studies in electrochemistry). Moscow, Nauka, 1965, 198-204

TOPIC TAGS: potassium, rubidium, cesium, sodium, carbonate, electrolysis

ABSTRACT: The potentials of deposition of alkali metals on mercury from 0.1 N aqueous solutions of their carbonates were determined: Cs, -2.022 V; Na, -2.030 V; Rb, -2.054 V; K, -2.060 V. The dependence of the transfer of alkali metals into mercury on the cathode potential was established; from this dependence, the half-wave potentials of alkali metals were obtained: Cs, -2.096 V; Na, -2.104 V; Rb, -2.122 V; K, -2.138 V. The separation factors of a series of alkali metal pairs (Rb and K, Na and K, Cs and K, Na and Rb, Cs and Rb, Na and Cs) on a mercury cathode were determined for the electrolysis of 0.1 N aqueous solutions of carbonates of these metals at a constant cathode potential. These factors were found to be small: even in the most favorable case, in

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L 45844-66

ACC NR: AT6024974

which the deposition potentials of the Cs-K pair differ by 0.04 V, the separation factor is only 4.25. This shows that under the conditions studied, the separation of alkali metals by electrolysis is very difficult, and a more complete separation can be achieved only in a multistage cascade process. Orig. art. has: 3 figures and 1 table.

SUB CODE: 07/11/ SUBM DATE: 04Feb64/ ORIG REF: 002/ OTH REF: 005

Card 2/2 blg

MAKAROV, D.I.; GOL'DBERG, A.S.; GESKIN, E.S.; GIL'MAN, S.M.; KRAVCHENKO, A.Ya.; GAMBAROV, V.I.

Simple control of air flow. Avtom.i prib. no.1:24-26 Ja-Mr '63.
(MIRA 16:3)

1. Ukrainskiy gosudarstvennyy proyektnyy institut "Metallurgavtomatika" (for all except Kravchenko, Gambarov). 2. Metallurgicheskiy zavod imeni Petrovskogo (for Kravchenko, Gambarov).
(Open-hearth furnaces) (Electronic control)

DEMIN, G.I.; PLUZHNIKOV, A.I.; CHURAKOV, A.M., inzh.; ZHILIN, I.S., inzh.; MAKAROV, D.M., inzh.; LEBEDEV, N.D., inzh.; SHISHLOV, D.D., inzh.; IGLIN, V.P., inzh.; YEVLAYEV, E.S., laborant; KISELEV, V.V., laborant; KOTEL'NIKOV, V.V., laborant; TYULENEVA, N.I., laborant

Transfer of a holding furnace to heating by natural gas with self-carburation. Stal' 23 no.8:755-758 Ag '63. (MIRA 16:9)

1. Moskovskiy institut stali i splavov (for Demin, Pluzhnikov).
(Furnaces, Heating)

BOGOYAVLENSKIY, M.S.; VASHCHENKO, A.I.; DENISOV, A.N.; ZHETVIN, A.N.; ZEN'KOVSKIY, A.G.; MAKAROV, D.M.; MAKSIMOV, B.M.; FILATOVA, A.I.; SHABUNIN, Ye.M.

Oxidation and decarburizing of certain steels in duo-muffle furnaces of nonoxidizing heating. Stal' 23 no.12:1124-1126 D '63. (MIRA 17:2)

MAKAROV, D.V.

USSR/Chemical Technology. Chemical Products and Their Application--Treatment of natural gases and petroleum. Motor fuels. Lubricants. I-13

Abs Jour: Ref Zhur-Khimiya, No 3, 1957, 9308

Author : Lavrovskiy, K. P., Makarov, D. V., and Nazarova, L. M.
Inst : Petroleum Institute of the Academy of Sciences USSR
Title : The Combined Deep-Seated Hydrogenation Method

Orig Pub: Tr. In-ta nefti AN SSSR, 1956, Vol 8, 145-154

Abstract: The combined deep-seated hydrogenation of residual oils from Romashkin crude has been investigated in pilot plant installations of the continuous type. The charge stock (d_4^{20} 0.965, 10.3% boiling below 350°, 17.8% boiling between 350 and 400°) is mixed with 2% carbon-base Fe-catalyst and subjected to a single-pass hydrogenation in a tubular reactor at 470° and 350 atm; the reactor throughput is 2.5 kg/liter/hour. A contact time of 3 min is used. The hydrogenate obtained in 90% yields is subjected

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USSR/Chemical Technology. Chemical Products and Their Application--Treatment of natural gases and petroleum. Motor fuels. Lubricants. I-14

Abs Jour: Ref Zhur-Khimiya, No 3, 1957, 9308

Abstract: to distillation; a residue boiling above 470° (7.8% of the residual oil charge) and containing 23.5% asphaltenes is separated. A broad cut (boiling below 470°), containing no asphaltenes, is sent through a second hydrogenation treatment over a highly active fixed bed catalyst (WoS_2) at 390-400° and 200 atm; the throughput of the second stage is 2.0 kg/liter/hour with a recycle coefficient of 1.08. No poisoning of the catalyst is observed and the yield of hydrogenate (d_4^{20} 0.7995, gasoline of bp below 200° 43,5%, gas oil of bp 200-340° 46.5%, aromatic hydrocarbons 22.5%. naphthenic paraffins 77.5%, S 0%) is 97%. The application of combined deep-seated hydrogenation to petroleum distillation residues rich in asphaltenes and resins makes possible a marked increase

Card 2/3

PAVLOVSKIY, M.M.; MAKAROV, D.V.

Refining of highly unsaturated distillates over aluminosilicate catalysts. Trudy Inst.nefti 13:241-249 '59. (MIRA 13:12)
(Gasoline)

MAKAROV, D.V.; NAZAROVA, L.M.

Autofining process of mixed fractions. Trudy Inst.nefti 13:250-255 '59. (MIRA 13:12)

(Petroleum--Refining)

MAKAROV, D.V., FISH, Yu.L.

Two-stage hydrogenation of highly aromatized sulfur-bearing distillates. Trudy Inst.nefti 13:256-261 '59. (MIRA 13:12)
(Petroleum--Refining)

LAVROSKIY, K.P.; MAKAROV, D.V.; FISH, Yu.L.

Two-stage hydrogenation of commercial benzene in the presence of mixed catalysts. Neftekhimiia 1 no.4:509-513 Jl-Ag '61. (MIRA 16:11)

1. Institut neftekhimicheskogo sinteza AN SSSR.

PAVLOVSKIY, M.M.; MAKAROV, D.V.

Refining highly unsaturated gasoline with activated aluminum oxide. Zhur. prikl. khim. 34 no.5:1107-1110 My '61. (MIRA 16:8)

(Aluminum oxide) (Gasoline)

BRODSKIY, A.M.; LABROVSKIY, K.P.; MAKAROV, D.V.; MEZENTSEV, A.N.; FISH, Yu.L.

Radiation-thermal cracking of gas oil. Neftekhimiia 2 no.3: 332-338 My-Je '62. (MIRA 15:8)

1. Institut neftekhimicheskogo sinteza AN SSSR.
(Cracking process) (Petroleum products)

L 01238-67 FWT(m) JR

ACC NR: AT6031142 SOURCE CODE: UR/3136/66/000/066/0001/0024

AUTHOR: Aleksenko, Yu. N.; Brodskiy, A. M.; Zabelin, A. I.; Kevrolev, V. P.; Lavrovskiy, K. P.; Makarov, D. V.; Tetyukov, V. D.; Fish, Yu. L. 42 B+1

ORG: none

TITLE: Analysis of tests of a unit for the atomic power station "Arbus" 19 for regenerating a gas oil coolant by degeneration hydrogenation

SOURCE: Moscow. Institut atomnoy energii. Doklady, IAE-1066, 1966. Analiz ispytaniy ustanovki destruktivno-gidrogenizatsionnoy regeneratsii gazoylevogo teplonositelya AES Arbus, 1-24

TOPIC TAGS: organic moderated reactor, organic coolant, atomic energy, atomic power station, organic cooled nuclear reactor, catalyst, catalyst regeneration/Arbus-I atomic power station

ABSTRACT: An analysis is made of data obtained in the experimental operation of the "Arbus-I" atomic power station and related laboratory studies. The "Arbus-I" differs from other atomic power stations using organic-cooled and-organic-moderated reactors in that its gas oil coolant is regenerated by means of a hydrogenation-

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L 01238-67

ACC NR: AT6031142

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degradation process. The investigation showed that regeneration through hydrogeneration-degradation considerably decreases radiolytic losses in the coolant. The principal parameters for the regeneration of hydrostabilized gas oils are given and the useful life of the aluminocobalt molybdenum catalyst under adopted operating parameters is determined. Orig. art. has: 8 figures and 5 tables. [SP]

SUB CODE: 20/ SUBM DATE: none/

Card 2/2 awm

MAKAROV, E. F., GOL'DANSKII, V. I., KHRAPOV, V. V.,

"Structural Studies of Tin-Organic Carboxylates, Poylmer Tin-Organic Oxides and Related Compounds by the Mossbauer Effect,"

report presented at the 3rd Intl. Conf. on the Mossbauer Effect, Cornell Univ., New York, 4-7 Sep 63

MAKAROV E. L

PHASE I BOOK EXPLOITATION 927

Mezhvuzovskaya konferentsiya po svarke, 1956

Sbornik dokladov...(Reports of the Interuniversity Conference on Welding, 1956) Moscow, Mashgiz, 1958. 266 p. 7,000 copies printed.

Sponsoring Agency: Moscow. Vyssheye tekhnicheskoye uchilishche.

Ed.: Nikolayev, G.A., Doctor of Technical Sciences, Professor; Ed. of Publishing House: Mezhova, V.A.; Tech. Ed.: Tekhanov, A.Ya.; Managing Ed. for Literature on Heavy Machine Building (Mashgiz): Golovin, S.Ya., Engineer.

PURPOSE: This book is intended for welding engineers and technical personnel of scientific research organizations.

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COVERAGE: This is a collection of technical papers and reports presented by the representatives of various educational, industrial, and research organizations at the 1956 welding conference. They deal with problems of strength of welded connections and structures, automatic arc and resistance welding of steels, and nonferrous metals and alloys. No personalities are mentioned. There are 109 references, 95 of which are Soviet, 12 English, and 2 German.

TABLE OF CONTENTS:

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APPROVED FOR RELEASE: 06/20/2000 CIA-RDP86-00513R001031510001-9"

MAKAROV, E.L.

SOV-135-58-9-6/20

AUTHORS: Prokhorov, N.N., Doctor of Technical Sciences, Professor and Makarov, E.L., Engineer

TITLE: Methods of Evaluating Steel Resistance to Cold Crack Formation in Welding (Metodika otsenki soprotivlyayemosti staley obrazovaniyu kholodnykh treshchin pri svarke)

PERIODICAL: Svarochnoye proizvodstvo, 1958, Nr 9, pp 15-18 (USSR)

ABSTRACT: Information is presented on methods of investigating the sensitivity of welded joints in different grades of steel (chemical composition given in a table) to cold crack formation. The proposed methods were developed by the authors together with K.I. Zaytsev and Aspirant Syuy-Tszy-Tsay (1950 - 1955). The article contains detailed description of tests, investigated specimens, devices and technology used, including investigation of zones adjacent to seams, artificial cooling, preheating and subsequent heating of the specimens. The performed tests proved that

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SOV-135-58-9-6/20

Methods of Evaluating Steel Resistance to Cold Crack Formation in Welding

the described method can be successfully applied in scientific research organizations in order to gather data for practical use. There are 6 diagrams, 5 graphs, 1 table, 2 sets of photos and 2 Soviet references.

ASSOCIATION: MVTU imeni Baumana (MVTU imeni Bauman)

1. Welded joints--Fracture 2. Welded joints--Test results

Card 2/2

MAKAROV, E. L., Candidate Tech Sci (diss) -- "Investigation of the resistance of steels to the formation of cold fissures in welding". Moscow, 1959. 15 pp (Min Higher Educ USSR, Moscow Order of Lenin and Order of Labor Red Banner Higher Tech School im N. E. Bauman), 150 copies (KL, No 24, 1959, 138)

SOV/129-59-3-3/16

AUTHORS: Prokhorov, N.N., Doctor of Technical Sciences, Professor and Makarov, E.L., Gospodarevskiy, V.I., Engineers

TITLE: Investigation of the Kinetics of Decomposition of Austenite in Steels During Welding (Issledovaniye kinetiki raspada austenita v stalyakh pri svarke)

PERIODICAL: Metallovedeniye i Termicheskaya Obrabotka Metallov, 1959, Nr 3, pp 13 - 16 (USSR)

ABSTRACT: "Cold cracks" during welding form in the process of decomposition of austenite. The kinetics of decomposition of austenite are determined to a considerable extent by the resistance of the steel to the formation of cold cracks. Cottrell (Refs 1, 2) as well as the authors of this paper investigated the relation between the temperature of completion of the decomposition of austenite (measured dilatometrically) and the resistance of the steels to the formation of cold cracks during welding. Critical temperatures were established at which the process of decomposition of the austenite is completed and below which the tendency of the steels to crack formation increases sharply. In this paper, the kinetics of the decomposition of austenite was investigated

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SOV/129-59-3-3/16

Investigation of the Kinetics of Decomposition of Austenite in Steels During Welding

magnetometrically of welded specimens on a specially designed instrument, the principle of operation of which is based on recording of the changes in the magnetic properties of the steel during $Fe_{\gamma} \rightarrow Fe_{\alpha}$ transformation in the process of cooling after welding. In the thermally influenced zone of the basic metal the material changes into the austenitic state and becomes non-magnetic. During decomposition of the austenite the welded joints assume a magnetic conductivity. Recording of the changes in the magnetic conductivity of the welded joint together with changes in the temperature in the zone around the joint at the fusion line permits investigating the kinetics of decomposition of the austenite during welding. A sketch of the instrument is shown in Figure 1, p 14. It consists of a П-shaped core which carries two coils; one of these generates a DC flux in the core; the other measures the magnetic flux of the core. During operation the magnetic circuit is closed with the welded specimen,

Card2/4 which consists of two plates, 10 x 50 x 100 mm; these

SOV/129-59-3-3/16

Investigation of the Kinetics of Decomposition of Austenite in Steels During Welding

are open-circuited prior to welding. During cooling of the specimen after welding the magnetic circuit is gradually closed by the welded joint as the austenite decomposes. Re-establishment of the magnetic conductivity in the welded joint of the specimen leads to an increase in the magnetic flux of the core. The resulting changes of the magnetic flux induces an e.m.f. in the metering coil which is either measured by a galvanometer or recorded oscillographically simultaneously with the temperature of the specimen. The chemical compositions of the steels from which the test specimens were made are entered in a table, p 15. In one series of experiments, the speed of cooling of the specimens from 500 °C was 5 °C/sec; in another, it was 20 to 25 °C/sec. In Figure 4, the temperatures of austenite decomposition during welding are garphed for various steels. In Figure 5, the dependence is graphed of the resistance of steels against the formation of cold cracks during welding on the temperature of completion of the austenite decomposition (Curve A) and on

Card3/4 the maximum intensity of the austenite decomposition (Curve B).

SOV/129-59-3-3/16

Investigation of the Kinetics of Decomposition of Austenite in Steels During Welding

The described method of study of the kinetics of decomposition of the austenite during welding enables approximate evaluation of the resistance of steels to forming cold cracks as a result of various regimes of welding.
There are 5 figures, 1 table and 3 references, 2 of which are English and 1 Soviet.

ASSOCIATION: MVTU imeni Bauman

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18(5,7) SOV/135-59-8-4/24

AUTHORS: Prokhorov, N.N., Doctor of Technical Sciences, Makarov, E.L., Engineer, and Yakushin, B.F., Engineer

TITLE: Strength of Steel in the Process of Austenite Transformation During Welding

PERIODICAL: Svarochnoye proizvodstvo, 1959, Nr 8, pp 12-15 (USSR)

ABSTRACT: Metallographic examinations of the cold cracks in the zone thermic effect in joints of low-alloy steels show, that the cracks are brittle and are mostly found at the periphery of the initial authenite cores. Figure 1 shows a microphoto of a typical crack in the zone near a welding seam of low-alloy steel. It can be seen that the crack goes along the edge of the cores and only in some cases cuts through the core. Figure 2 shows a cold crack of short length, which was found in the zone of thermic influence on a sample of low-alloy steel, which had been tested in regard to its tendency to form cracks. This microphoto clearly shows the inter-crystalline character of the cold cracks. An analysis of the damages in the formation

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SOV/135-59-8-4/24

Strength of Steel in the Process of Austenite Transformation During Welding

of cold cracks thus permits the assumption, that cold cracks are formed on the edges of the cores. In the literature this assumption is confirmed. Consequently a kinetic analysis of the mechanical qualities in the disintegration process of the austenite, taking in regard certain conditions causing the inter-crystalline destruction of the steels, must be the basis for an estimation of the tendency of steels to form cold cracks. If the timing conditions are neglected in the tests, the character of the destruction is changed, i.e. the inter-crystalline destruction is replaced by the inner-crystalline one. The results obtained in such tests cannot be used to estimate the tendency of the steels to form cold cracks during the welding. There is no agreement between the mechanical characteristics of the steel under the conditions in the zone of thermic influence of the welding seam and the tendency of these steels to form cold cracks during the welding. In tests with constant loads, however a certain agreement between these characteristics was

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Strength of Steel in the Process of Austenite Transformation During Welding

obtained. In these tests the steel decayed because of brittleness, which was partly inter-crystalline and partly inner-crystalline, under loads which were considerably below the breaking strength. The destruction of the steel in this case was similar to that, which was observed as a cause of the formation of cold cracks in the zone of the thermal influence of the welding. The study which is here presented gives the results of mechanical tests of steels, which were heat-treated in the welding cycle under different speeds of deformation. For the tests a machine was constructed which differs from the common types by that its motion speed for the moveable arms was changed in the limits of 22 - 0,00015 mm/s. The machine consists of the following main parts the system to heat the sample in the given time by exposing it to an electric current; the mechanical gear; and the mechanism to register the strength and the elongation of the part during the destruction. The scheme of the machine is given in figure 3. In the following

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Strength of Steel in the Process of Austenite Transformation During Welding

part the machine is described in detail. The diagram "force-deformation" is written on a sheet of paper which is fixed on a drum. The methods of the examinations were developed in the welding laboratory of the MVTU and are perfected in this study. The tests were carried out with flats of 3x15x135 mm with a circular turned hole in the center. The tests were carried out for three thermic cycles which are characterized by a heating up to 1300°C in 8-10 sec. and a medium cooling speed of 5, 20, and 200°C sec at 500°C. The deformation strength was determined by the bending power of the dynamometric spring. After the destruction the durability limits and the cross contraction were determined. The thermic welding cycle in testing the formation of cracks was selected similarly to that in the tests of the mechanical characteristics. As the data show that the durability changes under retarded destruction just as the resistability of steels against the formation of cold cracks in the welding. Analyzing the inter-crystalline

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Strength of Steel in the Process of Austenite Transformation During Welding

destructions of the metal it must by all means be considered that it is caused by certain conditions of temperature and time of the load and the structure of the metal. The resistability to deformations on the edges of the cores changes with the alterations in the toughness of the inter-crystalline layers and in the deformation speed. In the deformation process of the austenite the inter-crystalline layers are also tough, but the tenacity rises considerably. The mechanical characteristics of steel, which is treated in a thermic welding cycle, can be used for a relative estimation of the strength of the basic metal to resist the formation of cracks in welding. There are 4 photographs, 4 graphs, 2 diagrams and 12 references, 7 of which are Soviet and 5 English.

ASSOCIATION: MVTU im. Baumana (Moscow Higher Technical School im. Bauman)

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SOV/32-25-2-21/78

18(7)

AUTHORS: Prokhorov, N. N., Makarov, E. L., Gospodarevskiy, V. I.

TITLE: Methods of Physical Examination (Fizicheskiye metody issledovaniya). The Investigation of the Decomposition Kinetics of Austenite in Steels Under the Conditions of a Thermal Welding Cycle (Issledovaniye kinetiki raspada austenita v stalyakh v usloviyakh termicheskogo tsikla svarki)

PERIODICAL: Zavodskaya Laboratoriya, 1959, Vol 25, Nr 2, pp 164 - 166 (USSR)

ABSTRACT: The decomposition kinetics of austenite determine the character of the mechanical property changes in steel (e.g. the increase of internal structural tensions and the factors influencing the cold-shortness). The investigations described in the present paper were carried out by means of a newly designed photomechanical special dilatometer. The apparatus works on the principle of determining the test distortions by measurements of photoresistors (of the FS-K2 type). The thermal processing of the dilatometric samples is done by passing through electric current. The dilatometer consists of a mechanical distortion meter, an optical system and the photoresistor with an electron amplifier (Fig 1).

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Methods of Physical Examination. The Investigation of the Decomposition Kinetics of Austenite in Steels Under the Conditions of a Thermal Welding Cycle SOV/32-2?-2-21/7

The sample (3 x 5 x 100 mm) can be quickly heated to a high temperature by passing through a powerful current. It is protected from oxidation by being placed in an inert-gas circuit. The temperature is measured by thermoelements, and the cooling velocities are recorded on an oscillograph 1) at 500°, approximately 20° per second, and 2) at 500° and approximately 5° per second. 15 types of steel were tested (Table), the samples were heated up to 1200°, and the cooling was done by one of the two cycles mentioned above. A representation of the thermal cycles and dilatometric curves of the 40Kh steel is contained in the paper (Fig 2). In the tests with an electrode (with a UONII 13/45 cover) on weakly alloyed wire, the steel welding was carried out in accordance with the thermic cycles of the dilatometric investigations. The investigation results (Fig 4) prove that under the welding conditions described, with austenite decomposition and temperatures below 300°, steels show a marked reduction of the resistance to cracking due to low temperatures. There are 4 figures and 1 table.

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Methods of Physical Examination. The Investigation of the SOV/32-25-2-2'/78
Decomposition Kinetics of Austenite in Steels Under the Conditions of a
Thermal Welding Cycle

ASSOCIATION: Moskovskoye vyssheye tekhnicheskoye uchilishche im. Baumana
(Advanced School of Technology im. Bauman)

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S/125/61/000/011/001/012
D040/D113

AUTHORS: Prokhorov, N.N. and Makarov, E.L.

TITLE: Methods of determining and controlling the resistance of steels to cold cracking during welding

PERIODICAL: Avtomaticheskaya svarka, no. 11, 1961, 3-13

TEXT: A detailed description of a new cold cracking test method is given, and the hypothesis of steel strength on which the method is based, is discussed. The principle of the method consists in the application of an external force, produced by a weight, during the time when austenitic transformation occurs in the welded specimen. The method, suggested by N.N. Prokhorov, was verified in experiments with various steel grades and electrode materials in manual and automatic welding. It is stated that existing tests for the technological strength of steel in welding do not always properly reflect the strength under actual welding conditions, and reference is made in this connection to several foreign and Soviet tests including those conducted by K.G. Nikolayev and B.A. Gololobov (Ref. 4: "Svarochnoye proizvodstvo", No. 9, 1956). The theory underlying the new method provides for a subdivision of

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D040/D113

Methods of determining ...

the stresses in the welded metal into active (in the weld and the affected zone) and reactive (in base metal beyond the affected zone) stresses, and the applied external load imitates the "reactive" effect. The shape of specimens may be different - T, butt joint, etc. A T-specimen and the suggested test machine design are illustrated (Fig. 1 and 2). The test consists in loading a series of specimens with weights of different sizes. Load is gradually applied 2-30 minutes after welding, for a period of 0.5-1 minute, and is held for at least 20 hours. The time of complete rupture of the specimens is fixed, and specimens left solid are investigated for cracks. The test results are presented in graphs showing the destructive stresses and destruction time. The quantitative cracking resistance index is the minimum tensile stress that causes rupture or cracks. Cracks are revealed by etching with a weak solution of nitric acid poured on the metal. The minimum possible loading time is conditioned by the cooling of the affected zone, down to 400-350°C, i.e. the start of austenitic transformation. The specimens have to be large enough to allow internal stresses, depending on the properties of the weld and the base metal, to form. The article includes details of test techniques,

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Methods of determining ...

specimen dimensions, the composition of some of the tested steel grades, and graphs illustrating the test results. The effect of various technological means of raising the crack resistance was investigated, i.e. preheating, roasting of electrodes and fluxes, forging, selecting the composition of weld metal, etc. Forging is stated to be a very effective means of combatting cracking in the affected zone, which is apparently due to stress relief in the specimens. There are 6 figures, 3 tables and 9 references: 6 Soviet and 3 non-Soviet-bloc references. The three references to English-language publications read as follows: C.L.M. Cottrell, H.D. Jackson, I.G. Whitman, Control of Cracking in Arc Welding High Tensile Structural Steels, "Welding Journal", No. 4, 1952; S.L. Hoyt, C.E. Sims, H.M. Banta, Metallurgical Factors of Underbead Cracking, "Welding Journal", No. 9, 1945; C.B. Voldrich, Cold Cracking in the Affected Zone, "Welding Journal", No. 3, 1947.

ASSOCIATION: MVTU im. Baumana (MVTU im.Bauman)

SUBMITTED: June 19, 1961

Card 3/4

MAKAROV, E.L.

Remarks on the theory of hot crack formation. Lit. proizv. no.4:
48 Ap '62. (MIRA 15:4)
(Metal castings--Defects)

MAKAROV, E.L., kand.tekhn.nauk

Plasticity of steel in the austenite transformation process during welding. Trudy MVTU no.106:66-71 '62. (MIRA 16:6)
(Steel--Welding) (Plasticity)

41866

S/549/62/000/106/006/010
I003/I203

/ 2300

AUTHOR: Makarov, .L., Cand. Techn. Sciences

TITLE: A comparison of various methods for determining the resistance of steels to cold cracking during welding

SOURCE: Moscow. Vyssheye tekhricheskoye uchilishche. [Trudy] no. 106, 1962. 137-148. Svarka tsvetnykh splavov i nekotorykh legirovannykh staley

TEXT: The effectiveness of the methods described by S.L. Hoyt, C.E. Sims, and H.M. Banta in the Welding Journal, 1945, No. 9, and by C.B. Voldrich in the Welding Journal, 1947, No. 3, is compared with that of the CTS and LTP methods developed in the MVTU im. Bauman. The author comes to the conclusion that the methods of Hoyt and Voldrich make it possible to evaluate only a very limited number of materials, because of the extreme thermal conditions created during testing. The CTS method permits the evaluation of a wider assortment of materials, as it combines real thermal conditions during welding with rather extreme thermal stresses. The LTP method permits the evaluation of the resistance to cracking of all materials, under any welding conditions. There are 8 figures and 2 tables.

Card 1/1

MAKAROV, E.L., kand.tekhn.nauk

Effect of moisture of electrode materials on steel resistance to the formation of cold cracks during welding. Trudy MVTU no.106:149-156 '62. (MIRA 16:6)

(Steel—Brittleness) (Electrodes)

L 10287-67 EWT(m)/EWP(v)/EWP(t)/EWP(k)/ETI JD/HM/GD

ACC NR: AT6030943 (A) SOURCE CODE: UR/0000/66/000/000/0143/0150

AUTHORS: Makarov, E. L. (Candidate of technical sciences); Gospodarevskiy, V. I. (Engineer)

ORG: none

TITLE: A study of the effect of the dissociation of excess austenite on the appearance of cold cracks in welding

SOURCE: Moscow. Vyssheye tekhnicheskoye uchilishche. Prochnost' svarnykh konstruktsiy (Strength of welded structures). Moscow, Izd-vo Mashinostroyeniye, 1966, 143-150

TOPIC TAGS: welding, welding technology, austenite steel, austenite, metal welding

ABSTRACT: The role of decomposition of excess austenite in the appearance of cold cracks in welding was studied. A brief review of the "state of the art" is given. The authors note that the conclusions of some investigators show that there is much disagreement on how excess austenite leads to cracking of welded materials. An experimental study of the effect of the process of dissociation of austenite on cold-crack formation was conducted in the laboratory Technological Strength of Metals in Welding, MVTU (Tekhnologicheskaya prochnost' metallov pri svarke MVTU). Experiments were conducted using two methods: the magnetometric method on specimens of the dilatometric type and on welded specimens with supercooling. The magnetic method is more convenient for studying austenite dissociation in steel specimens, and a special

device based on magnetic induction was designed for the experimental work. A schematic diagram of the apparatus is given with a brief description of its operation. Measurements were made with several steels to ascertain the variation of the resistance of steels to the formation of cold cracks in welding with the characteristics of the process of excess austenite decomposition. Other measurements were made to determine the supercooling thermal cycle (see Fig. 1),

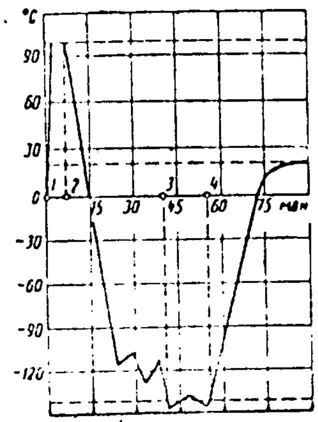

Fig. 1. The thermal cycle of supercooling of specimens after welding to negative temperatures. 1--2 - heating period; 2--3 - period of cooling to a low temperature; 3--4 - duration at low temperature

and low temperature effects on strength were recorded for various steels. The authors conclude that none of the applied methods of study in which the process of excess

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ACC NR: AT6030943

austenite dissociation is directly or indirectly [illegible] established leads to a direct relationship between the d[illegible] formation of cold cracks in welding. Orig. art. has: 5 figures.

SUB CODE: 11, 13/ SUBM DATE: 11Mar66/ ORIG REF: 005/ OTH REF: 002

Card 3/3

ACC NR: AT6030942 (A) SOURCE CODE: UR/0000/66/000/000/0133/0142

AUTHOR: Makarov, E. L. (Candidate of technical sciences)

ORG: none

TITLE: The effect of preliminary thermal processing of steel on the process of cold-crack formation in welding

SOURCE: Moscow. Vyssheye tekhnicheskoye uchilishche. Prochnost' svarnykh konstruktsiy (Strength of welded structures). Moscow, Izd-vo Mashinostroyeniye, 1966, 133-142

TOPIC TAGS: welding technology, welding, metal welding, crack formation, pearlite, steel, aluminum, titanium, niobium/ 30KhGSA steel

ABSTRACT: Preliminary thermal treatment of steel before welding has an effect on the process of cold-crack formation. Thermal treatment changes the degree of uniformity of the hard mixture, the state of the carbide phase, the grain size, the grain edges, etc. Several earlier research efforts in this field are cited, and brief summaries of findings are given for studies on chromium-molybdenum steels and steels with aluminum, titanium, and niobium additives. The current article describes research performed on various forms of preliminary thermal processing of 30KhGSA steel (0.33 C; 1.03 Si; 0.91 Mn; 0.80 Cr; 0.14 Ni). The studies were aimed at improving the resistance of the material to the formation of cold cracks by controlling the basic structure. The

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ACC NR: AT6030942

effectiveness of the following types of preliminary processing was tested: homogenization, annealing with lamellar pearlite, hardening and drawing, annealing with granular pearlite, tempering and drawing after annealing with granular pearlite. These various thermal processes are contrasted with regard to their tendencies to promote or inhibit cold-crack formation. Results presented include microstructure photographs, microhardness values in the parent metal and in the vicinity of a joint, and dilatometric curves for conditions of a weld thermal cycle. Orig. art. has: 6 figures.

SUB CODE: 11, 13/ SUBM DATE: 11Mar66/ ORIG REF: 002/ OTH REF: 004

Card 2/2

ACC NR: AT6030946 (N) SOURCE CODE: UR/0000/66/000/000/0227/0242

AUTHORS: Makarov, E. L. (Candidate of technical sciences); Subbotin, Yu. V. (Engineer); Prokhorov, N. N. (Doctor of technical sciences)

ORG: none

TITLE: Means for increasing the resistance of steels to the formation of cold cracks during welding

SOURCE: Moscow. Vyssheye tekhnicheskoye uchilishche. Prochnost' svarnykh konstruktsiy (Strength of welded sturctures). Moscow, Izd-vo Mashinostroyeniye, 1966, 227-242

TOPIC TAGS: weld effect, weld evaluation, metal welding, welding equipment, welding technology, metal bonding

ABSTRACT: An analysis was made and an experimental study was conducted to determine means for increasing the resistance of steels to the formation of cold cracks during welding. Basically, nine methods are identified: 1) the rational alloying of basic and built-up metal; 2) the selection of weld materials of a defined content with minimal hydrogen content; 3) the selection of the optimal technology and welding conditions; 4) the processing of the basic metal before welding so as to obtain a favorable base structure; 5) the elimination of the effect of stress concentrators by varying the surface layer properties of the metal; 6) control of the welding thermal cycle; 7) thermomechanical treatment of the weld joint during cooling in the welding

ACC NR: AT6030946

process; 8) thermal treatment of the weld joint immediately after welding; 9) mechanical working at the weld joint immediately after welding. The results of several weld strength tests are presented. In these tests the strength of the welds was measured for a variety of conditions, including hand and automatic welding, use of several types of weld materials and base materials, direct versus alternating current welding, etc. Other tests were for the purpose of contrasting the effect of preliminary cold working on steel in the normalized versus the annealed condition. Failed specimens are shown, a discussion of the various failure mechanisms is presented, and surface conditions are analyzed with respect to their effects on crack formation. Further experimental analyses were performed on commercial steels to determine the effect of the weld-cooling rate on the weld bond. Test results were compared with theoretical studies on the welding thermal cycle. Orig. art. has: 13 figures.

SUB CODE: 11/ 13/ SUBM DATE: 11Mar66/ ORIG REF: 007/ OTH REF: 014

Card 2/2

L 14725-66 EWT(d)/EWT(m)/EWP(z)/T/ETC(m)-6/ IJP(c) WW/EM/DJ

ACC NR: AP6003986 SOURCE CODE: UR/0145/65/000/008/0042/0045

AUTHOR: Makarov, E. S. (Senior lecturer)

ORG: Rybinsk Aviation-Technological Institute (Rybinskiy aviatsionno-tekhnologicheskiy institut)

TITLE: Multi-frequency vibrator with an eccentric wheel mechanism

SOURCE: IVUZ. Mashinostroyeniye, no. 8, 1965, 42-45

TOPIC TAGS: electric vibrator, vibration synthesis, forced vibration, Fourier series

ABSTRACT: For successful compacting of ground, the natural frequency of the vibrator on the ground must be near the frequency of the exciting forces. To follow the changing frequency, the vibrator has to provide a force consisting of a number of desired harmonics. This can be accomplished by a multi-frequency vibrator with eccentric gears as shown in Fig. 1. If the desired excitation force is to change according to the relationship

$$P(\varphi_1) = 2m\omega_1^2 r S(\varphi_1),$$

(where ω_1 and ϕ_1 = input angular velocity and shaft angle; $S(\phi_1)$ = function

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ACC NR: AP6003986

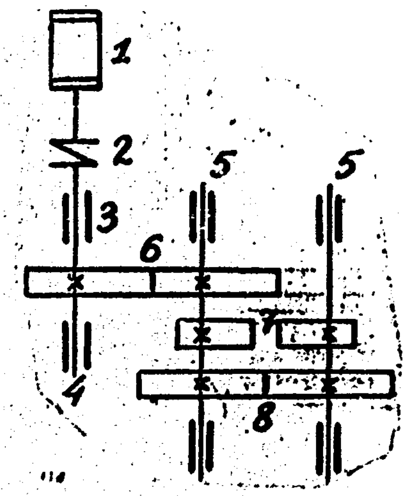

Fig. 1. Kinematics of multi-frequency vibrator: 1 - electric drive; 2 - elastic coupling; 3 - bearings; 4 - input shaft; 5 - driven shaft; 6 - eccentric gears; 7 - unbalances; 8 - gears with i = 1.

consisting of desired harmonics) then ϕ_2 must satisfy

$$\varphi_2'^2 \sin\varphi_2 - \varphi_2'' \cos\varphi_2 = S(\varphi_1)$$

(where ϕ_2 = driven shaft angle, primes refer to differentiation with respect to ϕ_1)

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ACC NR: AP6003986

or equivalently

$$\varphi_2' \cos \varphi_2 = i_0 - \int_0^{\varphi_1} S(\varphi_1) d\varphi_1,$$

and

$$\varphi_2 = \arc\sin \int_0^{\varphi_1} \left(i_0 - \int_0^{\varphi_1} S(\varphi_1) d\varphi_1 \right) d\varphi_1.$$

From these, the transfer function $i = \phi_2'$ can be found, and the eccentric gears can be constructed. In practice, elliptical gears have found wide application. In these, if e = eccentricity of the ellipse, then the expressions

$$\varphi_2' = \frac{i_{max}}{\cos^2 \frac{\varphi_1}{2} + i^2_{max} \sin^2 \frac{\varphi_1}{2}} = i; \quad \varphi_2'' = -\frac{i_{max} (i^2_{max} - 1) \sin \varphi_1}{2\left(\cos^2 \frac{\varphi_1}{2} + i^2_{max} \sin^2 \frac{\varphi_1}{2}\right)^2}$$

can be substituted into the equation for $S(\phi_1)$, and the latter can be expanded in a Fourier series (where $[1 + e]/[1 - e] = i_{max}$). The functions $i(\phi_1)$ and $S(\phi_1)$ for e = 0, 1/5, and 1/3 are plotted. Orig. art. has: 3 figures and 7 formulas.

SUB CODE: 13/ SUBM DATE: 14Jun63/ ORIG REF: 002

forced vibrations 24

BVK

Card 3/3

MAKAROV, E.V.

Use of helicopters in b[illegible] assembling [illegible] tekh. i melior. [illegible] no. [illegible]:1?8-1?? [illegible].

APPROVED FOR RELEASE: 06/20/2000 CIA-RDP86-00513R001031510001-9"

MAKAROV, E.V.

Reproduction of Azov [illegible] Trudy VNIRO no.24:203-[illegible] [illegible]

1. Azovskiy nauchno-issledovatel'skiy institut rybnogo khozyaystva.

APPROVED FOR RELEASE: 06/20/2000 CIA-RDP86-00513R001031510001-9"

MAKAROV, F.F.; SAFONOVA, Z.V.

Hydrogenated petrolatum for fat liquoring of hard and Russian leather. Biul.tekh.-ekon.inform. no.5:57-58 '59.
(MIRA 12:8)

(Tanning)

SAFONOVA, Z.V., kand.tekhn.nauk; MAKAROV, F.F.

Using hydrogenated petrolatum for stuffing sole and Russian leather. Kozh.-obuv.prom. 2 no.5:17-19 My '60. (MIRA 13:9)
(Leather) (Petrolatum)

MAKAROV, F.F.

Treatment of chrome tanned Russian leather used in manufacturing footwear by means of hot vulcanization. Biul.tekh.-ekon.inform. no.3:48-50 '61. (MIRA 14:3)

(Tanning)